

The background image is a composite. The left side shows an aerial view of a forested hillside with a dirt road and some buildings in the distance. The right side shows a clear blue sky with a large, leafy tree in the foreground. The text is overlaid on these images.

**What's going on  
with my trees?**

**Climate effects on  
forest health**



# Forestry In South Carolina



- ~ 12 million acres
- Forestry is big industry!
- 73% of the forest land is privately owned

# Climate Change...

- **Modify tree defenses**
- **Damage trees: wind, snow, frosts, or ice**
- **Change boundaries of species**
- **Change in plant species**
- **Understory vegetation**
- **Soil organisms**

# Forest Change Responses...

- **Nutrient cycling**
  - soil nutrient availability
  - amount and seasonality of litter inputs
  - decomposition rates
  - plant litter quality
- **Hydrological processes**
- **Soil moisture**



# Forest Change Responses...

- **Species composition**
  - tree mortality =  $\wedge$  debris
  - $\wedge$  debris =  $\wedge$  fire
  - $\wedge$  fire =  $\wedge$  fire adapted species
- **Debris influences fire frequency, risk, intensity**



- Accelerate nutrient cycling
- Tree mortality
- Succession
- Induced seed germination
- Loss of soil seed bank





# Fire Damage





# Fire and Climate Change

- Increased fuel loads
- Longer fire seasons
- More extreme fire weather conditions
- Expected increased forest fire activity

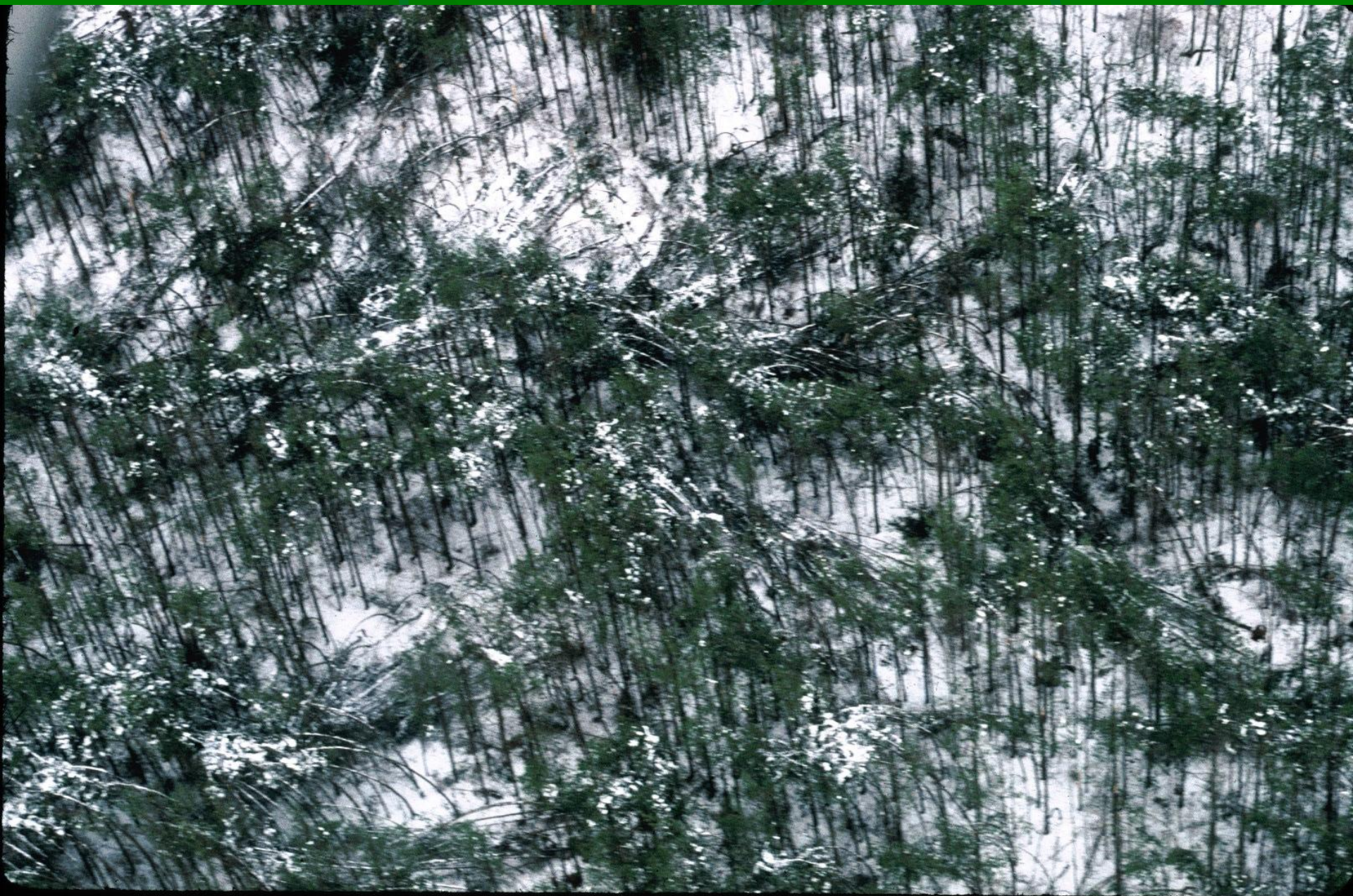


# Direct Events

- **High winds/ice/snow damage to trees:**
  - branch breaking
  - crown loss
  - trunk breakage
  - stand destruction



# Snow/Ice Damage





# Tornado Damage



29/09/2004







# Hurricane Damage



# Hurricane Damage

- Shift in succession
- Species turnover
- Opportunities for species change



# Tree Responses to Drought

**\* Species differ \***

- **Boost secondary chemical metabolites (+)**
- **Leaves waxier (+)**
- **Leaves ^ sugar content (-)**
- **Leaves ^ N (-)**
- **Lower resistance (-)**

# Warmer/Drier...

- Larger populations of insects survive winter
- Allows them to develop faster
  - additional generations
  - reduced parasitism opportunity
- Ranges expand northward
- Trees' ability to resist insect attack reduced



# Specific Examples

- **Armillaria root disease**
- **Hypoxylon canker**
- **Defoliators**
- **Hemlock Woolly Adelgid**
- **Pine beetles**

# Armillaria Root Disease

- Conifers and hardwoods
- Grows on tree roots
- Opportunistic, prefers stressed trees
  - Oaks, sugar maples
  - Grows exponentially
- Warmer/drier conditions trees @ > risk
  - act > part of year



# Shoestring Root Rot





# Armillaria

- Spread primarily through root-to-root contact
- Spread along root to root collar & to other primary roots
- Death: tree girdled at the root collar
- Bark beetles or windthrow



# Hypoxylon Canker



29/10/2004



# Hypoxylon Canker

- Affects various hardwoods
  - Oak                      Beech
  - Hickory                Maple
- Most trees have the fungus living innocuously under the bark
- Kills trees when they are stressed:
  - drought, damage, root disease, etc.











- Spores
- Produced in spring or summer





# Defoliation





# Forest Tent Caterpillar







# Forest Tent Caterpillar

- **One generation/year**
- **Synchrony with leaf out**
- **Early leaf out**
  - reduced growth rates
  - longer larval stages
  - lower pupal masses
  - reduced female fecundity
- **Migrating birds**

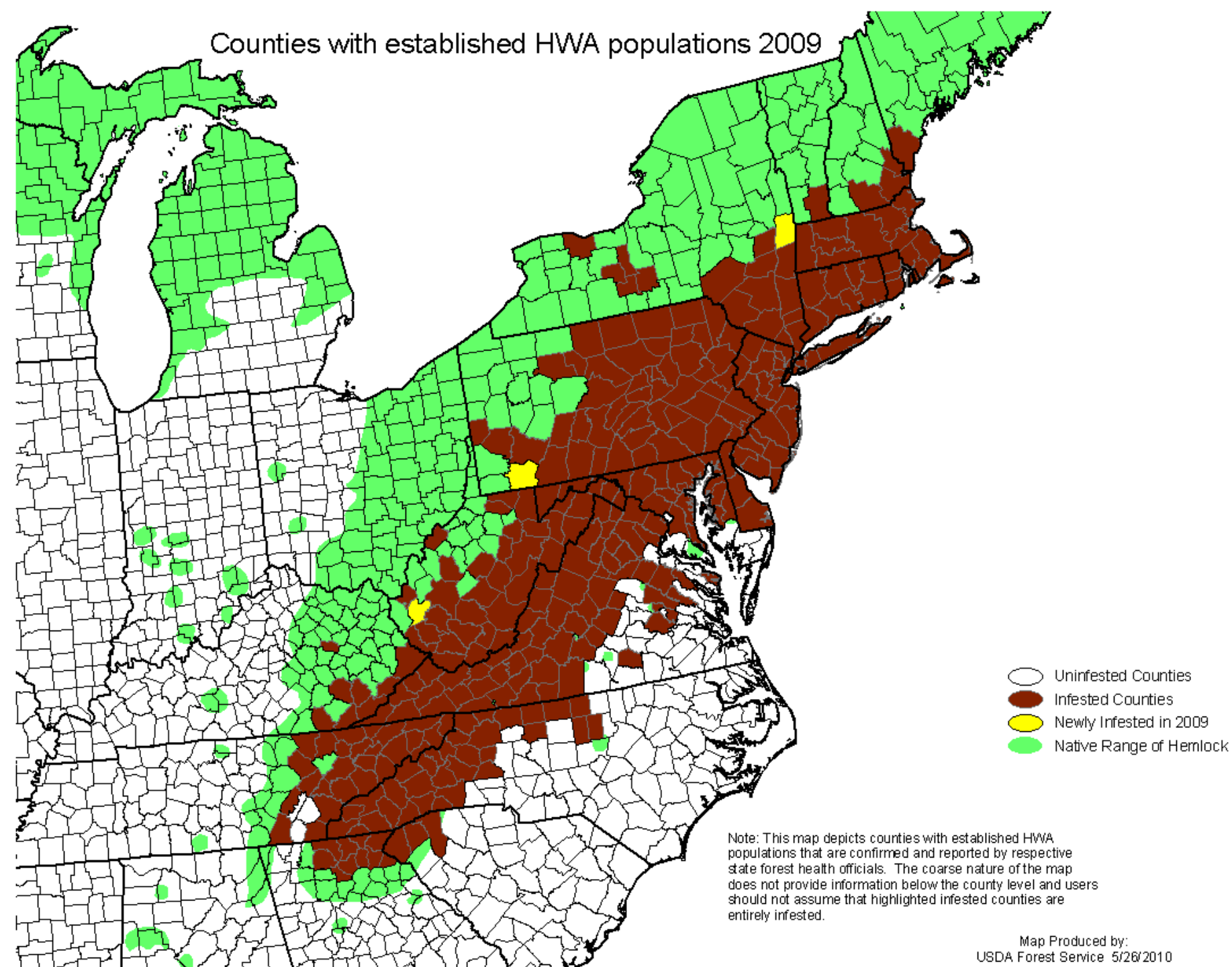


# Hemlock Woolly Adelgid



UGA3225077

## Counties with established HWA populations 2009



Note: This map depicts counties with established HWA populations that are confirmed and reported by respective state forest health officials. The coarse nature of the map does not provide information below the county level and users should not assume that highlighted infested counties are entirely infested.



HWA Adult

HWA Eggs

UGA1276002



Adult HWA  
without wax



UGA1276003





**Fish Hatchery**

An aerial photograph showing a dense green forest. A white, diagonal structure, likely a wing or tail fin of an aircraft, is visible on the left side. In the upper center, a rectangular building with a light-colored roof is visible, surrounded by trees. A large black oval is drawn around a section of the forest in the center-right, highlighting a specific area. The date '29/09/2004' is printed in yellow in the bottom right corner.

*HWA infested  
trees*

29/09/2004

# Hemlock Woolly Adelgid

- Stabilized mean winter temps  $-5^{\circ}\text{C}$  or less
  - keep HWA from expanding
- Mild winters:
  - ^ survival & fecundity
  - ^ population levels = ^ tree decline
- Changes in forest composition, structure, nutrient cycling, surface water quality, and populations of associated wildlife



**Ips**

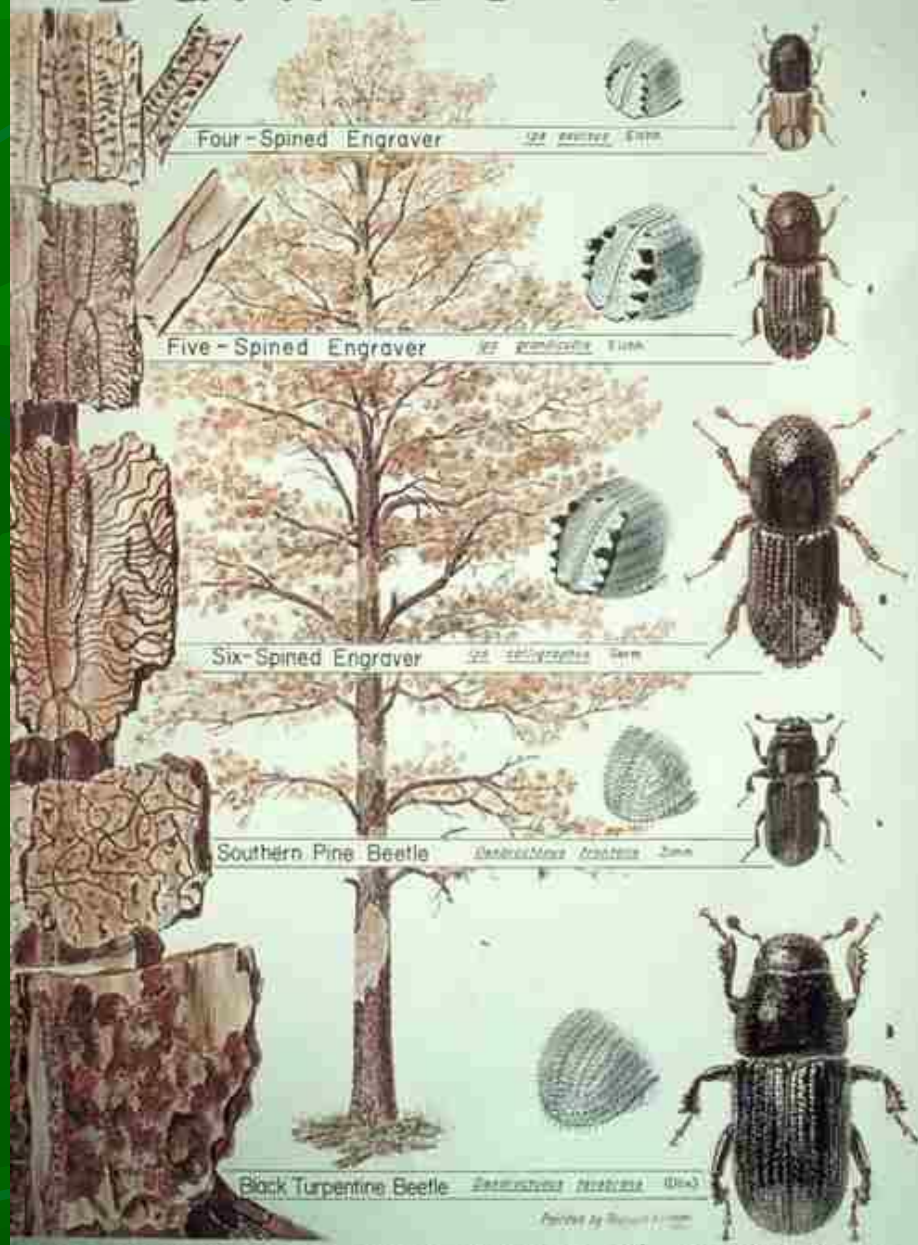
**SPB**

**BTB**



UGA0284001b

# Bark Beetles



For Plant Research, Forest Research Lab., Beaumont, Tex. 1961

UGA0284002





29/09/2008





UGA2716114





2007/05/08



# Ips



**Prefer stressed trees:**

- drought stress
- lightning struck
- root/logging damage

# Ips Galleries



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28/01/2008



# Southern Pine Beetle



- Strong fliers
- Move easily from tree to tree and stand to stand















# Southern Pine Beetle



21/07/2004







# Ticks



**Male**

**Female**





# Climate Change

- **Modify tree defenses**
  - Pine trees reduced resin
- **Influences the survival and spread of pathogens**
  - susceptibility of their hosts
- **Direct Damage: wind, snow, frosts, or ice**



# Climate Change

- **Allow for northern expansion**
- **Change in overstory, change in understory**
- **Change in insect winter survival/biology**
- **Increase invasive species (adaptability)**





**Laurie Reid**  
**Forest Entomologist**

**[lreid@forestry.state.sc.us](mailto:lreid@forestry.state.sc.us)**  
**(803) 896-8830**





# Eastern Tent Caterpillar



UGA1435084

28/03/2006

Laurie Reid, SCFC



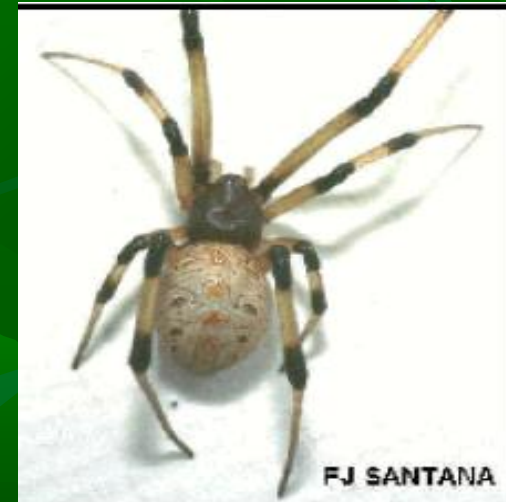


28/03/2006

Laurie Reid, SCFC



# Brown Widow





The background of the slide is a dark green color with a pattern of lighter green, stylized leaves and branches. The leaves are elongated and pointed, with visible veins. The branches are thin and intersecting, creating a network-like pattern across the slide.

<http://www.bugwood.org>

<http://www.fs.fed.us/r8/foresthealth/laurelwilt/index.shtml>

<http://www.state.sc.us/forest/id.htm>